

# A Review of the Scientific Names of Chinese Cabbage according to the International Codes of Nomenclature

Yoon-Young Kim<sup>1,9\*</sup>, Sang Heon Oh<sup>1\*</sup>, Wenxing Pang<sup>2</sup>, Xiaonan Li<sup>2</sup>, Seong-Jin Ji<sup>3</sup>, Eunho Son<sup>4</sup>, Saehee Han<sup>5</sup>, Suhyoung Park<sup>6</sup>, Eeunhe Soh<sup>7</sup>, Hoil Kim<sup>8</sup>, and Yong Pyo Lim<sup>1\*</sup>

<sup>1</sup>Department of Horticulture, Chungnam National University, Daejeon 34134, Republic of Korea

<sup>2</sup>College of Horticulture, Shenyang Agricultural University, Shenyang 110866, China P.R.

<sup>3</sup>Facilities and Management Division, National Science Museum, Daejeon 34143, Republic of Korea.

<sup>4</sup>National Agrobiodiversity Center, National Institute of Agricultural Science, Suwon 16613, Republic of Korea.

<sup>5</sup>National Agrobiodiversity Center, National Institute of Agricultural Science, Jeonju 54874, Republic of Korea

<sup>6</sup>Department of Horticultural Crop Research, National Institute of Horticultural and Herbal Science, Jeonju 55365, Republic of Korea

<sup>7</sup>Seobu Branch Office, Korea Seed & Variety Service, Iksan 54521, Republic of Korea.

<sup>8</sup>ReSEAT program, Korea Institute of Science and Technology Information, Seoul 02456, Republic of Korea.

<sup>9</sup>National Park Research Institute, Korea National Park, Wonju 26441, Republic of Korea.

\*Corresponding author: [yplim@cnu.ac.kr](mailto:yplim@cnu.ac.kr)

<sup>†</sup>These authors contributed equally to this work.

Received: December 02, 2016

Revised: December 28, 2016

Accepted: December 29, 2016

 OPEN ACCESS



HORTICULTURAL SCIENCE and TECHNOLOGY  
35(2):165-169, 2017  
URL: <http://www.kjhst.org>

pISSN : 1226-8763  
eISSN : 2465-8588

This is an Open-Access article distributed under the terms of the Creative Commons Attribution NonCommercial License which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Copyright©2017 Korean Society for Horticultural Science.

This research was supported in part by the "Golden Seed Project (No. 213002-04-4-SB110)", Ministry of Agriculture, Food and Rural Affairs (MAFRA), Ministry of Oceans and Fisheries (MOF), Rural Development Administration (RDA) and Korea Forest Service (KFS); "Regional Subgenbank Support Program (No. PJ012148)" of Korea Rural Development Administration (RDA); the ReSEAT program funded by the Ministry of Science, ICT and Future Planning through the National Research Foundation of Korea and the Korea Lottery Commission grants.

## Abstract

We organized the scientific names of Chinese cabbage according to the International Code of Nomenclature for algae, fungi, and plants (ICN) and the International Code of Nomenclature for Cultivated Plants (ICNCP). We found that the subspecies name '*Brassica rapa* subsp. *pekinensis* (Lour.) Rupr.' was suitable as the scientific name for Chinese cabbage, and we classified *B. rapa* var. *glabra* Regel. as its synonym. In addition, *B. petsai* Bailey is an 'unrecorded name' not found in the original description, and therefore is not suitable for use. We conclude that all names based on this name are 'invalid names', and should not be used.

**Additional key words:** *Brassica rapa* subsp. *pekinensis*, Brassicaceae, ICN, ICNCP.

## Introduction

According to the APG (Angiosperm phylogeny Group) III system (<http://www.mobot.org/MOBOT/research/APweb/>), the family Brassicaceae belonging to order Brassicales. Worldwide, 338 plant genera and approximately 3,700 species are known to be distributed across the temperate zones (Al-Shehbaz et al., 2006 b). Chinese cabbage is a species that, together with rapeseed (*Brassica napus* L.), mustard greens (*B. juncea* (L.) Czern.), and cabbage (*B. oleracea* L.), belongs to the genus *Brassica* L. (Warwick et al., 2006).

Chinese cabbage is one of the major vegetables produced in Korea together with radish (*Raphanus sativus* L.), red pepper (*Capsicum annuum* L.), garlic (*Allium sativum* L.), and onion (*Allium cepa* L.). In

In addition to being the major ingredient in the Korean traditional food Kimchi, Chinese cabbage is widely used in the general Asian cuisines of Korea, China, and Japan in dishes such as Namul (vegetable dishes such as Saengchae, which is made with uncooked raw vegetables, and Sukchae, which is made with boiled, steamed), stir-fries, salads, vegetable wraps, stews, and soups. Various scholars and institutions in Korea and abroad use different scientific names for Chinese cabbage, which causes confusion in the scientific literature. This confusion makes it challenging to establish and manage databases, and may introduce errors in research results.

Therefore, we examined the scientific names for Chinese cabbage that are currently in use internationally, including Korea, China, and Japan, where the largest amounts of Chinese cabbage are consumed. This study identifies the most suitable scientific name for Chinese cabbage, based on the International Code of Nomenclature for algae, fungi, and plants (ICN) (McNeill et al., 2012) and the International Code of Nomenclature for Cultivated Plants (ICNCP) (Brickell et al., 2009), in an attempt to alleviate the confusion around the nomenclature.

## Status of the Scientific Name of Chinese Cabbage

### Korea

The scientific name of Chinese cabbage in Korea was first recorded as *Brassica campestris* L. by Chung et al. (1937). However, *B. campestris* subsp. *napus* var. *pekinensis* (Lour.) Makino was later regarded as the correct name by various scholars (Lee, 1980; Lee, 1996; Lee, 2003; Chung et al., 2004; Lee, 2006). Among these scholars, Lee (1996) treated *Sinapis pekinensis* Lour., *B. petsai* Bailey and *B. pekinensis* (Lour.) Rupr. as synonyms. The Ministry of Environment and the Korea Forest Service recorded Chinese cabbage as *B. rapa* var. *glabra* Regel (Oh, 2007a, 2007b), while the National Academy of Agricultural Science Rural Development Administration (2009) considered *B. rapa* subsp. *pekinensis* (Lour.) Hanelt as the correct scientific name. On the other hand, Chang et al. (2014) recently classified *Sinapis pekinensis* Lour., *B. pekinensis* (Lour.) Rupr., and *B. petsai* (Lour.) L.H. Bailey as the alternative names of *B. oleracea* L., and incorporated *B. rapa* var. *glabra* Regel into *B. rapa* L.

### China

Zhou et al. (2001) considered *B. rapa* var. *glabra* Regel as the correct name, and treated other scientific names as synonyms, including *B. campestris* L. subsp. *pekinensis* (Lour.) G. Olsson; *B. campestris* var. *pekinensis* (Lour.) Viehoveer; *B. chinensis* var. *pandurata* V. G. Sun; *B. chinensis* var. *pekinensis* (Lour.) V. G. Sun; *B. pekinensis* (Lour.) Rupr.; *B. pekinensis* var. *cephalata* M. Tsen & S. H. Lee; *B. pekinensis* var. *cylindrica* M. Tsen & S. H. Lee; *B. pekinensis* var. *laxa* M. Tsen & S. H. Lee; *B. pekinensis* var. *petsai* Lour.; *B. petsai* (Lour.) L. H. Bailey; *B. rapa* subsp. *pekinensis* (Lour.) Hanelt; *B. rapa* subsp. *pekinensis* var. *laxa* (M. Tsen & S. H. Lee) Hanelt; *B. rapa* subsp. *pekinensis* var. *pandurata* (V. G. Sun) Gladis; and *Sinapis pekinensis* Lour.

### Japan

Tsunoda et al. (1980) organized a list of wild species belonging to the genus *Brassica*, and listed '*pekinensis* (Lour.)' under *B. rapa* without any clear explanation of the order. Al-Shehbaz et al. (2006a) considered *B. rapa* var. *glabra* Regel as the correct name, and considered *Sinapis pekinensis* Lour., *B. pekinensis* (Lour.) Rupr. as the alternative name. Ylist (<http://ylist.info/>) also considered *B. rapa* var. *glabra* Regel as the correct name, and classified *B. rapa* var. *pekinensis* (Lour.) Kitam., *B. pekinensis*

(Lour.) Rupr., and *B. rapa* var. *amplexicaulis* subvar. *pe-tsai* (L.H. Bailey) Kitam. as alternative names.

## Other Countries

The Plant List (<http://www.theplantlist.org/>) classified the above-mentioned names of Chinese cabbage, including *B. rapa* subsp. *pekinensis* (Lour.) Hanelt (Mansfield, 1986), *B. campestris* L. (Linnaeus, 1753), and *B. rapa* var. *glabra* Regel (Regel, 1860), as the alternative names of *B. rapa*.

However, the majority of recent theses based on molecular genetics have classified them as subspecies names (Oh et al., 2015; Tan et al., 2015; Zhang et al., 2015; Chun et al., 2016; Lee et al., 2016; Yang et al., 2016).

## Nomenclature

***Brassica rapa* subsp. *pekinensis* (Lour.) Hanelt**, Verz. Landwirtsch. Gärtner. Kulturpfl. (ed. 2) 1: 304 (1986) —Type: not designated<sup>1</sup> ≡ *Sinapis pekinensis* Lour., Fl. Cochinch. 2: 400 (1790) ≡ *B. pekinensis* (Lour.) Rupr., Fl. Ingr. 96 (1860) ≡ *B. campestris* subsp. *napus* var. *pekinensis* (Lour.) Makino, J. Jap. Bot. 8: 8 (1932) ≡ *B. rapa* var. *pekinensis* (Lour.) Kitam., Acta Phytotax. Geobot. 35: 125 (1984) ≡ *B. chinensis* var. *pekinensis* (Lour.) V.G. Sun, Bull. Torrey Bot. Club 73: 374 (1946) ≡ *B. campestris* subsp. *pekinensis* (Lour.) G. Olsson, Hereditas (Lund) 40: 414 (1954).

<sup>2</sup> *B. rapa* var. *glabra* Regel, Gartenflora 9: 9 (1860) —Type: “Herr Skatschkoff, Russischer Consul in China, hatte dem H. Ministerium der Domainen eine reiche Sammlung von ungefähr 500 verschiedenen Arten Chinesischer Gemüse eingesendet”.

<sup>3</sup> *Sinapis pekinensis* var. *petsai* Lour. —unrecorded name.

– *B. petsai* (Lour.) L.H. Bailey, Cornell Univ. Agric. Exp. Sta. Bull. 67: 178 (1894) —invalid name.

– *B. chinensis* var. *petsai* (L.H. Bailey) Maire & Weiller, Fl. Afrique N. 12: 166 (1965) —invalid name.

– *B. rapa* subsp. *pekinensis* (Lour.) Kitam. —unrecorded name.

**Korean name:** Bae-chu (배추), Bae-chae (배채), Bae-cha (배차)

**Chinese name:** Bái-cái (白菜), Cǎi (菜), Dà-bái-cái (大白菜), huáng-yá-cái (黄芽菜)

**Japanese name:** Ha-ku-sa-i (ハクサイ, はくさい)

**English name:** Chinese cabbage, Kimchi cabbage, Celery cabbage

## Discussion

Chinese cabbage (*B. rapa* subsp. *pekinensis*) was originally named *Sinapis pekinensis* Lour. and “Pêt-fái”, which was produced in the Beijing region of China, was reported as a new species (Loureiro, 1790). Later, Ruprecht (1860) reclassified Chinese cabbage from the genus *Sinapis* to the genus *Brassica*, and gave it the new name *B. pekinensis* (Lour.) Rupr. In 1984, Kitamura classified it as a variety of *B. rapa* (turnip), and named it *B. rapa* var. *pekinensis* (Lour.) Kitam. Sun (1946) degraded it as a variety of *B. chinensis* (bok choy) and introduced the new name *B. chinensis* var. *pekinensis* (Lour.) V.G. Sun. Olsson (1954) considered it as a subspecies of *B. campestris*, and coined the name *B. campestris* subsp. *pekinensis* (Lour.) G. Olsson. By contrast, *B. petsai*, reported by Bailey (1894), is an ‘**unrecorded name**’ that has not been recorded in the original description.

<sup>1</sup> Nomenclatural synonym

<sup>2</sup> Taxonomic synonym

<sup>3</sup> Illegitimate name

Therefore, it is not a usable scientific name according to the ICN (<http://www.iapt-taxon.org/>), and it is suggested that all new names based on *B. petsai* must be considered as ‘invalid names’, unsuitable for use.

American and European scholars classified *B. campestris* as the alternative name for *B. rapa* (Rollins, 1993; Zuloaga & Morrone, 1997; Sklenář et al., 2001; Hokche et al., 2008; Nelson, 2008; Zuloaga et al., 2008; Jørgensen et al., 2014). It is highly likely to be the same species as *B. rapa*, which originated in Europe. When compared with the lectotype of *B. campestris*, *B. rapa* subsp. *pekinensis* shows several morphological differences: the roots are thinner, the basal leaves are not arranged in rosette form, the leaf base has pinnules, and the basal leaves are smaller than the cauline leaves. Therefore, it is not desirable to incorporate the two different species into one.

The original description of *B. rapa* var. *glabra* corresponds with the morphological characteristics of Chinese cabbage, and therefore it is correct to classify it as the alternative name for *B. rapa* subsp. *pekinensis*. To ensure clarity, however, it is critical to verify the classification according to the type specimen collected by Skatschkoff.

Based on the above results, we conclude that the classification of Chinese cabbage should be at the subspecies level, and that ‘*B. rapa* subsp. *pekinensis* (Lour.) Rupr.’ should be considered its proper scientific name.

Although methods of classification that rely on molecular genetics studies based on markers are commonly used, they are limited. Therefore, it is necessary to conduct a more extensive and accurate study based on the whole genome. Studies involving morphological and evolutionary comparisons between related genera are likely to yield accurate classifications.

## Literature Cited

- Al-Shehbaz IA, Aria K, Ohba H (2006a) Cruciferae. In Flora of Japan, Vol 2a. Iwatsuki K, Boufford DE, Ohba H, eds, Kodansha Ltd., Tokyo, Japan.
- Al-Shehbaz IA, Beilstein M, Kellogg EA (2006b) Systematic and phylogeny of the Brassicaceae (Cruciferae): an overview. *Pl Syst Evol* 259:89-120. doi:10.1007/s00606-006-0415-z
- Brickell CD, Alexander C, David JC, Hettterscheid WLA, Leslie AC, Malecot V, Jin X, Cubey JJ (2009) International Code of Nomenclature for Cultivated Plant, Ed 8, Drukkerij Geers, Gent-Oostakker, Belgium.
- Chang CS, Kim H, Chang KS (2014) Provisional Checklist of Vascular Plants for the Korea Peninsula Flora (KPF). Designpost, Paju, Korea.
- Cho EG (2009) Crop Germplasm Catalogue: Vegetable Crops. Ed 8, National Academy of Agricultural Science Rural Development Administration, Suwon, Korea.
- Chun JH, Kim NH, Seo MS, Jin M, Park SU, Arasu MV, Kim SJ, Al-Dhabi NA (2016) Molecular characterization of glucosinolates and carotenoid biosynthetic genes in Chinese cabbage (*Brassica rapa* L. ssp. *pekinensis*). *Saudi J Biol Sci* in press. doi:10.1016/j.sjbs.2016.04.004
- Chung SJ, Kim WS, Cha GH, Han TH, Kim HG, Oh SO, Choi HG, Kim GJ (2004) Flora of Horticultural and Crop Plants in Korea. Chonnam National University, Gwangju, Korea.
- Chung TH, Do BS, Lee DB, Lee FJ (1937) *Nominia Plantarum Koreanum*. Chosen Natural History Society, Seoul, Korea.
- Hanelt PH (1986) in Mansfeld R *Verz Landwirtschaftl Gärtn Kulturpfl*, ed 2, Akademie-Verlag, Berlin, Germany.
- Hokche O, Berry PE, Huber O (2008) Nuevo Catálogo de la Flora Vascular de Venezuela. *Nuevo Cat Fl Vasc Venez* 1-859.
- Jørgensen PM, Nee MH, Beck SG (2014) Catálogo de las plantas vasculares de Bolivia, *Monogr Syst Bot Missouri Bot Gard* 127:1-8.
- Lee SG (2016) Impacts of climate change on the growth, morphological and physiological responses, and yield of Kimchi cabbage leaves. *Hortic Environ Biotechnol* 57:470-477. doi: 10.1007/s13580-016-1163-9
- Lee TB (1980) *Illustrated Flora of Korea*. Hyangmunsa, Seoul, Korea.
- Lee TB (2003) *Coloured Flora of Korea*. Hyangmunsa, Seoul, Korea.
- Lee WT (1996) *Lineamenta Florae Korea*. Academy Book, Seoul, Korea.
- Lee YN (2006) *New Flora of Korea*. Kyohaksa, Seoul, Korea.
- Loureiro J (1790) *Flora cochinchinensis*, vol 2. Ulyssipone, Lisbon, Portugal.
- Makino T (1932) A contribution to the knowledge of the flora of Nippon *J Jap Bot* 8:6-10.
- Mansfeld R (1986) *Verzeichnis landwirtschaftlicher und gärtnerischer Kulturpflanzen (ohne Zierpflanzen)*, Aufl 2. Springer-Verlag,

Berlin, Germany.

- McNeill J, Barrie FR, Buck WR, Demoulin V, Greuter W, Hawksworth DL, Herendeen PS, Knapp S, Marhold K, Prado J** (2012) International Code of Nomenclature for Algae, Fungi, and Plants (Melbourne Code). Regnum Vegetabile 154. Koeltz Scientific Books, Oberreifenberg, Germany.
- Nelson CH** (2008) Secretaria de Recursos Naturales y Ambiente, Tegucigalpa. Cat Pl Vasc Honduras 1-1576.
- Oh BU** (2007a) Brassicaceae. In A Synonymic List of Vascular Plants in Korea. Korea National Arboretum and The Plant Taxonomic Society of Korea. Korea National Arboretum, Pocheon, Korea. pp. 97-105.
- Oh BU** (2007b) Brassicaceae. In The Genera of Vascular Plants of Korea. Flora of Korea Editorial Committee ed, Academic Publishing Co., Seoul, Korea. pp. 427-461.
- Oh S, Moon KH, Song EY, Son IC, Koh SC** (2015) Photosynthesis of chinese cabbage and radish in response to rising leaf temperature during spring. Hort Environ Biotechnol 56:159-166. doi: 10.1007/s13580-015-0122-1
- Olsson G** (1954) Crosses within the campestris group of the genus Brassica. Hereditas (Lund) 40:398-418. doi: 10.1111/j.1601-5223.1954.tb02979.x
- Rollins RC** (1993) The Cruciferae of Continental North America. Stanford University Press, Stanford, United States of America.
- Ruprecht FJ** (1860) Flora Ingrica. Academiae, St. Petersburg, Russia.
- Stevens WD, Ulloa C, Pool A, Montiel OM** (2001) Flora de Nicaragua. Monogr Syst Bot Missouri Bot Gard 85:1-42.
- Sun VG** (1946) The evaluation of taxonomic characters of cultivated Brassica with a key to species and varieties-1. The characters Bull Torrey Bot Club 73:244-281. doi: 10.2307/2481549
- Tan HW, Song XM, Duan WK, Wang Y, Hou XL** (2015) Genome-wide analysis of the SBP-box gene family in Chinese cabbage (*Brassica rapa* subsp. *pekinensis*). Genome 58:463-477. doi: 10.1139/gen-2015-0074
- Tsunoda S, Hinata K, Gomez-Campo C** (1980) Brassica Crops and Wild Allies, Biology and Breeding. Japan Scientific Societies Press, Tokyo, Japan.
- Warwick SI, Francis A, Al-Shehbaz IA** (2006) Brassicaceae: Species checklist and database on CD-Rom. Pl Syst Evol 259:249-258. doi: 10.1007/s00606-006-0422-0
- Yang J, Liu D, Wang X, Ji C, F Cheng, Liu B, Hu Z, Chen S, Pental D, Ju Y, Yao P, Li X, Xie K, Zhang J, Wang J, Liu F, Ma W, Shopan J, Zheng H, Mackenzi SA, Zhang M** (2016) The genome sequence of allopolyploid *Brassica juncea* and analysis of differential homoeolog gene expression influencing selection. Nat Genet 48:1225-1232. doi: 10.1038/ng.3657
- Zhang J, Yuan H, Fei Z, Pogson BJ, Zhang L, Li L** (2015) Molecular characterization and transcriptome analysis of orange head Chinese cabbage (*Brassica rapa* L. ssp. *pekinensis*). Planta 241:1381-1394. doi: 10.1007/s00425-015-2262-z
- Zhou TY, Lu LL, Yang G, Al-Shehbaz IA** (2001) Brassicaceae (Cruciferae). In Flora of China, Vol 8. Wu ZY, Raven PH, eds, Science Press, Beijing, China and Missouri Botanical Garden, St Louis, United States America. pp. 1-193.